

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) A lead-free joining material, produced by a process comprising:
melting tin, zinc, and at least any one of bismuth and germanium as an additive
element to form a molten liquid;

forming the molten liquid into droplets; and

solidifying the droplets into particles;

wherein the particles comprise:

(a) a core part including zinc and tin as major components and at least any one
of bismuth and germanium as an additive element; and

(b) a surface layer covering the core part and including the major components
and the additive element, the surface layer including:

(i) a solid-solution phase in which a concentration of the additive
element is higher than a concentration of the additive element in the
core part, and the concentration of the additive element in the solid-
solution phase is in a range of 0.6 % to 1.0 % by weight; and

(ii) a needle crystal which is more than a core part, is dispersed in the
solid-solution phase and includes the zinc as a main component

wherein the concentration of the additive element in the core part is in a range
of 0.3 % to 1.0 % by weight, and the surface layer has a greater concentration of the
additive element than the core part,

wherein an average concentration of the additive element in the whole lead-free joining
material is in a range of 0.6 % to 1.0 % by weight.

2. (Cancelled)

3. (Previously Presented) The lead-free joining material according to claim 1,
wherein the surface layer has a depth of at least 2 μm from an outermost surface.

4. (Original) The lead-free joining material according to claim 1,
wherein the lead-free joining material is a particle which is substantially spherical.
5. (Cancelled)
6. (Currently Amended) A lead-free solder paste, comprising:
 - (A) a lead-free joining material, produced by a process comprising:
 - (1) melting tin, zinc, and at least any one of bismuth and germanium as an additive element to form a molten liquid;
 - (2) forming the molten liquid into droplets; and
 - (3) solidifying the droplets into particles;wherein the particles comprise:
 - (a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and
 - (b) a surface layer covering the core part and including the major components and the additive element, the surface layer including:
 - (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 1.0 %[[4.0 %]] by weight; and
 - (ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component;wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight;~~and~~ and the surface layer has a greater concentration of the additive element than the core part,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight; and
 - (B) a flux.
7. (Cancelled)
8. (Previously Presented) The lead-free solder paste according to claim 6,

wherein the surface layer has a depth of at least 2 μm from an outermost surface.

9. (Original) The lead-free solder paste according to claim 6,
wherein the lead-free joining material is a particle which is substantially spherical.

10. (Cancelled)

11. (Currently Amended) A joining method using a lead-free joining material, comprising:
coating a solder paste to a connection, the solder paste being formed by blending the
lead-free joining material and a flux, and
reflowing the solder paste,

wherein the lead-free joining material comprises a lead-free joining material,
produced by a process comprising:

- (1) melting tin, zinc, and at least any one of bismuth and germanium as an additive element to form a molten liquid;
- (2) forming the molten liquid into droplets; and
- (3) solidifying the droplets into particles;

wherein the particles comprise:

- (a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and
- (b) a surface layer covering the core part and including the major components and the additive element, the surface layer including;

- (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 1.0 %[[4.0 %]] by weight; and
- (ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component

wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight, and the surface layer has a greater concentration of the additive element than the core part.

wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.

12. (Cancelled)

13. (Previously Presented) The joining method according to claim 11,
wherein the surface layer has a depth of at least 2 μm from an outermost surface.

14. (Original) The joining method according to claim 11,
wherein the lead-free joining material is a particle which is substantially spherical.

15. (Cancelled)

16. (Currently Amended) A joining method using a lead-free joining material, comprising:
placing the lead-free joining material on a connection pre-coated with a flux; and
reflowing the flux and the lead-free joining material,
wherein the lead-free joining material comprises a lead-free joining material,
produced by a process comprising:

- (1) melting tin, zinc, and at least any one of bismuth and germanium as an additive element to form a molten liquid;
- (2) forming the molten liquid into droplets; and
- (3) solidifying the droplets into particles;

wherein the particles comprise:

- (a) a core part including zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and
- (b) a surface layer covering the core part and including the major components and the additive element, the surface layer including;

- (i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 1.0 %[[4.0 %]] by weight; and
- (ii) a needle crystal which is more than a core part, is dispersed in the solid-solution phase and includes the zinc as a main component

wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight, and the surface layer has a greater concentration of the additive element than the core part,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.

17. (Cancelled)

18. (Previously Presented) The joining method according to claim 16,
wherein the surface layer has a depth of at least 2 μm from an outermost surface.

19. (Original) The joining method according to claim 16,
wherein the lead-free joining material is a particle which is substantially spherical.

20. (Cancelled)

21. (Cancelled)

22. (Currently Amended) A method of making a lead-free joining material, comprising:
melting tin, zinc, and at least any one of bismuth and germanium as an additive element to form a molten liquid;
forming the molten liquid into droplets; and
solidifying the droplets into particles;
wherein the particles include:

(a) a core part that includes zinc and tin as major components and at least any one of bismuth and germanium as an additive element; and

(b) a surface layer covering the core part that includes the major components and the additive element, the surface layer including;

(i) a solid-solution phase in which a concentration of the additive element is higher than a concentration of the additive element in the core part, and the concentration of the additive element in the solid-solution phase is in a range of 0.6 % to 1.0 %[[4.0 %]] by weight; and

(ii) a needle crystal which is dispersed in the solid-solution phase and includes the zinc as a main component,
wherein the concentration of the additive element in the core part is in a range of 0.3 % to 1.0 % by weight, and the surface has a greater concentration of the additive element than the core part,
wherein an average concentration of the additive element in the whole lead-free joining material is in a range of 0.6 % to 1.0 % by weight.

23. (Cancelled)